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Where in the World Is Population Growth Bad?

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Would economic growth be better if population growth were slower? Everybody seems to agree the answer is "it depends" — but who knows on what?

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Summary findings

Would economic growth be better if population growth were slower?

There are two apparently opposite answers to this question. Advocates of policies to reduce population growth rates are completely convinced by the common sense view that rapid population growth greatly hurts economic growth because of scarcer natural resources, reduced investments (per child) in health and education, and lower rates of capital accumulation per worker.

The empirical evidence (usually marshalled by economists) provides an equally convincing, and seemingly contradictory, answer: There is no strong, stable relationship between countries' population growth and their per capita output growth rates.

Kling and Pritchett propose an empirical reconciliation between the two views.

No one really believes that the impact of a 10-percent increase in population would have the same impact in Bangladesh as it would have in Canada, or even the same impact in crowded Malawi or Rwanda as in sparsely populated Zaire or Zambia. But if the impact of population growth on economic growth differs across countries, it might *on average* be small (even statistically indistinguishable from zero) in the usual empirical estimates, even though the negative impact in *particular* countries might well be large.

The real answer might be, "It depends on country conditions." But this answer is uninformative unless one can show *which* country conditions "it depends" on. Is it most harmful in poor countries? In land-scarce countries? In countries with poor policies? Kling and Pritchett try to discover the conditions under which population growth hurts economic performance by allowing interactive terms for country conditions.

The empirical results do not give confirmation to any of the plausible distinctions across country conditions — the impact of population growth is not worse in poor countries and is not worse in land-scarce countries. Their measure of resource scarcity may be one reason for this failure to find an interaction, but while it failed to produce satisfying results, it is a major conceptual improvement over even simpler indicators, such as population density, or the empirical literatures studied: no interaction.

Identifying the conditions under which population growth is a drag on economic growth should be a priority as efforts to reduce population growth should be concentrated in those countries where the efforts give the greatest payoff.

This paper — a product of the Poverty and Human Resources Division, Policy Research Department — is part of a larger effort in the department to investigate the causes and consequences of rapid population growth. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Sheila Fallon, room N5-033, extension 38009 (37 pages). December 1994.

Where in the World Is Population Growth Bad?

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Where in the World is Population Growth Bad?

Would welfare be improved if population growth were lower? Specifically, as one part output per worker[1]? There exist two apparently opposite answers to this question. Advocates of policies to reduce population growth rates (generally demographers) are completely convinced by the common sense view that rapid population growth has large and deleterious effects on economic growth through a number of obvious channels-increased resource scarcity, reduced investments in health and education per child, and lower rates of capital accumulation per worker[2]. The empirical evidence (usually marshalled by economists) provides an equally compelling, and seemingly contradictory, answer: there is no strong, stable, relationship between countries' population growth and their per capita output growth rates.

In spite of the obvious contradiction, both views could be right. This paper proposes a empirical reconciliation of the two views. The usual statistical method for examining the relationship between growth and population (linear regression) automatically imposes on the data the restriction that the incremental impact of population growth be the same in all countries. Linear regression estimates this average impact. But no one really believes that the impact of a 10 percent increase in population would have the same impact in Bangladesh or Kenya as in Argentina or Canada. If the impact of population growth differs across countries it might on average be low (and even statistically indistinguishable from zero) even though the impact in

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[1] Of course there are many other ways in which population growth could worsen welfare that would not be captured in existing economic statistics. Effects through environmental degradation and congestion would worsen national welfare, but will be under recorded in national accounts. Moreover this paper does not address the potential spill-over affects from one's countries population or use of natural resources to another country's welfare, as would be the case with greenhouse gas emissions.

[2] The draft Programme of Action for the International Conference on Population and Development proclaimed "general agreement" that persistent widespread poverty is influenced by population growth (para 3.1).

particular countries might well be quite high. In that case the real answer from previous cross national evidence on the impact of population growth may well be: it depends.

That "it depends" is the impact of population growth would be a very good answer if we knew what it depends on, but we don't. Although there are many plausible assertions made (population growth is worse in poor countries, or worse in resource scarce countries, etc) there is little or no empirical evidence. This paper attempts to discover the conditions under which population growth worsens economic performance. The population growth-economic performance relationship is examined for various groups of countries defined by region, by income class, and by a measure of land scarcity. Unfortunately, we find no evidence that the effect of population growth differs in the expected ways. We believe we point the direction in which a convincing and useful reconciliation of the two strands of evidence on the impact on population must be found-a shifting of the population-growth relationship conditional on some observable characteristic. However, we fail in our quest to find a measurable variable which identifies those countries where population growth will be bad.

The first section reviews the basic stylized facts about population growth and economic performance and the existing empirical literature. The second examines the econometrics of a varying slope parameter: The third introduces the data and methods. The fourth examines variations in the effects of population growth and economic groups on average and across groups of countries, by region, and by income class, and by a measure of land scarcity.

D) Existing empirical evidence

There are three strands of empirical evidence which have failed to support the common sense view of the negative economic consequences of population growth.

First, there has been at best a weak correlation between the rate of growth of population and GDP per capita growth in the historical experience of the now developed countries. Kuznets (1967) surveyed the very long growth experience of a number of (now developed) countries and found no correlation between population growth and economic performance. This held true even excluding the areas of recent settlement to reduce the impact of endogenous changes in population through migration responding to economic opportunity[3].

Second, economic growth and population growth have clearly accelerated jointly over the course of human history[4]. Demographers have pointed out that world population growth has accelerated rapidly in recent centuries, rising from near zero anciently to rates above 2 percent (before falling recently). Economists have pointed out that growth rates of per capita income have also accelerated rapidly in the last centuries-especially recently. As Kuznets pointed out, since current income levels are the result of cumulative economic growth over past centuries, the fact that many countries began only recently growing rapidly from a very low base suggests

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[3] In the last two centuries the "areas of recent settlement" have had very rapid growth of both population and GDP per capita. All countries were able to sustain very rapid rates of GDP growth to allow growth per capita to be at least as rapid in the countries with very rapid population growth as opposed to the demographically more stable counter-parts. It is difficult to believe that GDP per capita in the U.S. (or Argentina) in 1930 would have been higher had immigration been curtailed in 1880, or 1820.

[4] There is something missing in the argument that since population is going to double in the next forty years this necessarily implies some negative consequences, because population growth doubled in the last forty years-and the last forty years are arguably the best forty years for progress in the history of mankind.

that current growth rates are much higher than growth rates in the far distant past[5]. Kremer (1993) provides empirical support for the proposition that, at least until the 1950s, more rapid world population growth has been associated with more, not less, rapid growth in world per capita output[6].

Third, examining the post-war experience of the developed and developing countries, numerous studies have found no consistent, statistically significant, correlation (or partial correlation) between GDP per capita growth and population growth. Literature surveys by Kelley (1988), Birdsall (1988) or the National Academy of Science (1986) typically conclude on an ambivalent note that the empirical evidence is not clear[7]. Kelley's (1988) statement, which fails to exclude any possibility for the impact of population growth (negative, zero, or positive), is typical:

> ... a bottom line assessment can be offered. Economic growth (as measured by per capita output) in many developing countries would have been more rapid in an

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[5] Although there is some debate about establishing a "subsistence" level of income, some minimum level of per capita output is necessary for demographic sustainability. The power of compound interest is such that, if poor countries had been growing over the "long term" at anything like the rates of the past fifty years they would be immensely richer than they actually are. That is, if output had grown by even 1 percent per capita for 200 years output would have increased seven-fold. But if the calculations of the "poverty level" for the 1990 World Development report are anywhere near accurate representation of a bare minimum level, most of the low income countries were more like 2 or 3 times the bare minimum in 1960. This implies that past growth, on average, must have been considerably slower than 1 percent per annum. Since growth in the post-war period in developing countries has been roughly 2 percent per annum, current growth is faster than historical growth by a multiple of at least three or four.

[6] Kremer, in the whimsically titled "Population growth and technological change: One million B.C. to the present" extends an argument of Kuznets (1960) about the essentially "public good" (e.g. non-rivalrous) nature of knowledge with the assumption that the production function of knowledge is constant returns with respect to population (more particularly, the educated population) to argue that worldwide technical change will increase with increased population.

[7] Even in the United Nations Population Fund's annual report State of the World Population, 1992 (an unlikely source for ambivalence on the negative impact of population growth) one finds the assertion "there was no correlation, negative or positive between economic and population growth" in the period up to 1980 (pg 8) (although coupled with a statement that this wasn't true over the 1980-89 period).

> environment of slower growth, although in a number of countries the impact was probably negligible, and in some it may have been positive.

Or more recently, Cassen (1994) summarizes the state of the art,

> Is seems likely that, in a poor country ... a growth rate that doubles the population in 20 or 30 years would harm the rate of improvement in living standards. But neither theory no econometrics has so far been able to demonstrate this relationship beyond doubt.

Table 1 summarizes the estimates of the impact of population growth from the literature using cross national regressions[8]. Population growth is not a robustly significant correlate of per capita output growth. As with the simple correlation, the partial correlations (linear regression coefficients) after controlling for other determinants of economic growth (either factor accumulation) or other factors (e.g., trade orientation) are typically small (most estimates are between -.14 and -.3)[9] and only a few of the results are statistically significant, depending on the variable definition, country sample, and time period.

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[8] The simple bivariate correlations are not reviewed here as there is ample discussion of those in other sources. Winfrey, 1992, provides a summary of correlation estimates from various countries and periods. Of the 14 studies with estimates for LDC samples for various periods only 4 show a statistically significant negative relationship (and those are from the more recent periods).

[9] Smallness, like beauty may be in the eye of the beholder. If the impact of population growth is .2 then a 1 percentage point decrease in population growth would lead to a .2 percentage point decrease in the per capita growth rate. About the largest conceivable reduction in population growth in developing countries is about 2 percentage points-which is roughly the average population growth difference between Sub-Saharan Africa of (2.8 percent) and the High income countries (.7 percent). This enormous (and implausible) reduction in population growth would only accelerate per capita growth by .4 percentage points-an effect on growth which is dwarfed by the actual observed variation in per capita growth rates in developing countries. The standard deviation of long-run growth is about 2 percent so that at an estimate of .2 a huge reduction in population growth would raise per capita growth by only about one fifth of a standard deviation.

Table 1: Regression estimates of the impact of population growth on the growth rate of per capita output.

Study	Estimate	t-statistic	Period
Levine and Renelt (1992)	-.15	.79	1960-85 (average)
Brander and Dowrick (1994)	-.27	1.45	1960-85 (five year averages)
Kelley and Schmidt (1994)[a]	.052	.63	1960-70
	-.21	.16	1970-80
	-1.32	3.2	1980-90
Barro (1991)	-.14	2.15	1960-85
Mankiw, Romer, Weil (1992)	-.14	1.75	1960-85
Landau (1986)	-.19	.93	1960-80
Ram (1986)	-.306	.87	1970-80
Kormendi and Meguire (1985)	-.42	2.47	1950-77

Notes: The details of each study (e.g., definitions of dependent and independent variable, estimation method, sample) are included in Appendix table A1.1.
Coefficients from the original studies have been transformed so the reported coefficient represents the impact on the per capita growth rate of a 1 percentage point acceleration in population growth.
a) Estimates are inclusive of interaction effects with level of income per capita, while t-statistics are for slope term alone.

The small and insignificant effect of population in regression estimates are often dismissed entirely by saying that the results are "difficult to interpret" or that "not much is learned" from country level aggregate studies which show a lack of correlation. While the studies may not have empirically confirmed the common sense view, and certainly have some deficiencies, these studies do establish two facts. First, on average, across countries and time periods, the higher population growth is <u>not</u> associated with significantly less rapid growth rates

of output per capita. Although this may not translate into any direct statement about the causation and structure the (near) lack of correlation is an observed fact that reasoning about population growth must accommodate.

Second, variations in population growth rates explain very little of the variation in growth rates across countries. Not surprisingly, countries' economic growth rates vary for many reasons besides population growth so that many low population growth countries also had low per capita growth while many high population growth countries also had high per capita growth. Table 2 presents those developing countries which were in the bottom third of the sample in growth rate of population and output per capita and those in the top third for both. Moreover, these examples are all for developing countries. Also, although Asian growth superstars is that even though their population growth was moderate for developing countries, they achieved rapid per capita growth even though their population growth was very rapid relative to the OECD countries. Even if we can establish population growth as an important determinant of economic growth in some situations, variations in population growth have simply not been a major factor in explaining relative growth performance.

Table 2: Countries with low population growth and poor performance and countries with high population growth and good performance.

Countries with low population growth (bottom third) and poor performance (bottom third)			Countries with high population growth (top third) and good performance (top third)		
Country	Population growth	Growth output per worker	Country:	Population growth	Growth output per worker
Argentina	1.5	1.1	Botswana	3.3	8.0
Chile	1.8	.1	Cote d'Ivoire	3.9	2.7
Guinea-Bissau	1.7	.4	Cameroon	2.8	4.6
Guyana	1.1	-2.1	Congo	3.0	4.3
Haiti	1.8	.2	Algeria	2.9	4.2
Jamaica	1.8	.1	Ecuador	2.9	3.2
Sri Lanka	1.8	.4	Gabon	3.3	7.7
Uruguay	.6	.9	Paraguay	2.9	2.8
			Syria	3.4	4.4
			Tanzania	3.0	2.7

Note: In this sample, average annual population growth was 2.1 percent (with a standard deviation of 1.0) and average growth of per worker output was 1.9 (with a standard deviation of 2.1).

Those are two important facts that have been learned from growth regressions. This does but this does leave two unanswered questions. First, where is population growth bad? The impact for a particular country or at a particular time is not necessarily the average impact. Some low income countries such as Bangladesh appear to be clearly suffering from overly dense population. Total and arable land per agricultural worker is extremely low, and falling, and the expansion of population onto increasingly marginal lands leads to rapid erosion even of the existing stock of productive land and frequent natural calamities as population presses onto marginal lands. Second, what causes what? Since both population growth and economic growth affect each other and are affected by other variables the association (or lack thereof) between

the two variables does not imply anything about the structure of causation between the variables.

The above facts imply that any simple assertion derived from Malthusian (or Neo-Malthusian) theories that population growth will everywhere and always worsen living standards must be wrong in at least some country and historical episodes. On the other hand an assertion that population is not a problem for economic growth anywhere seems also certain to be incorrect, in spite of the small average effect. This has led to the "revisionist" (neo-Malthusian) view, which seems to have emerged as the new consensus in some circles, that population growth is harmful to economic progress only under certain conditions[10]. This, for instance, is the conclusion reached by Cassen (1994) in his recent survey of the literature:

> What are the "new conclusions" to be drawn from all this? It seems fairly clear that population growth is not the overwhelming affliction that some have claimed and certainly not the prime cause of difficulties of development; but it also should not be regarded with equanimity. The degree of hindrance to the improvement of individual living standards that rapid population growth is likely to afford is hard to establish. It has not been helped by economists' models, which give the same result whether a country has a hundred or a hundred million people; whether the population is growing fast or slowly; whether the country is well-off or poor; and whether or not it has good government with sensible economic policies, equitable income distribution, well functioning markets and institutions and efficient agriculture with scope for expansion.

However these "revisionist" hypotheses about differences in the impact of population across types of countries, although attractive and plausible, have yet to be adequately explored or attract any empirical support.

The question is: if additional policy effort were successful in reducing the national fertility rate, would the result be higher lifetime output per person? If the answer is not

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[10] This is the view reflected in the 1984 World Development Report, (see also Birdsall, 1988) as well as the National Research Council report (NRC, 1986).

uniformly yes or no (and if the answer is uniform, the answer must be no) can the particular conditions and countries in which population growth is bad be identified?

II) The simple econometrics of interaction effects

Before examining the differences in the econometric results when countries are grouped by various categories, a simple review of what, empirically, we are looking for is useful. Say the true model is:

Equation 1: $y = \beta * l + \gamma * Z + \delta * (l * Z) + \epsilon$,

where lower case letters represent growth rates, so that y is growth in output per worker, l is the growth rate of the labor force, and Z is some variable or set of variables (e.g., resource scarcity, or income per capita) such that the effect of labor force growth on output growth is different depending on the value of Z. In this model the effect of l on output per worker growth is not simply β for all countries (as imposed by the linear model), but rather:

Equation 2: $\frac{\partial y}{\partial l} = \beta + \delta * Z$,

If there are interactions, the slope of the y-l relationship is not constant across countries. If the slope is not constant across countries then the coefficient on labor force growth in regressions of y on l that did not include Z could easily vary according to the sample.

In particular one could separate the sample according to the value of Z and run the regressions separately. For instance if the true model were given by equation 1 (and if l and

Z are uncorrelated) then if we sorted the data according to the value of Z, divided the sample at some (arbitrary) point z*, and ran two regressions:

Equation 3: $\hat{y}_i = \beta^l * \hat{l}_i + e_i \text{ if } Z_i < Z^*$
$\hat{y}_i = \beta^h * \hat{l}_i + e_i \text{ if } Z_i > Z^*$

The estimated value of β^l would converge to:

Equation 4: $plim\ \hat{\beta}^l = \frac{\partial y}{\partial l}|_{z<z^*} = plim\ \hat{\beta} + \hat{\delta} * \bar{z}^*$,

where the mean of z in equation 4 is taken over only those values of Z less than the cutoff point z*,

Equation 5: $\bar{z}^* = E(Z|Z < z^*)$.

When the samples are divided based on the value of Z (the variable that interacts with labor force growth) the coefficient on l in a regression estimated without the inclusion of the interaction term will be different. The magnitude of the difference between the coefficient on l in the samples will depend on the strength of the interaction effect and on the distribution of Z.

This suggests a method for the search for the instability of the regression coefficient over samples is to search for a variable to divide the sample and examine whether one finds plausible differences in the coefficients across the two sub-samples. Although in some ways dividing the

in the interaction term) there may be threshold effects. The negative impact of population growth may be very small up to a point and then increase dramatically. Below we generally use the average of possible Z values to divide the sample as we have no particular prior knowledge, but there is no reason to expect the critical value above which population consequences are severe corresponds to the average. The combination of average slope and cutoff point does put some limits on the values of the parameters however, as if the slope of the "worse" half of the sample is low, then either the slope even for the "worse" cases really is low, or only a small fraction of the countries are in the "worse" case.

A numerical example will illustrate this point that even if the effect is non-linear in some unknown threshold an arbitrary splitting of the sample should detect the relationship. Say the true model for the impact of labor force growth l on output per person growth y is non-linear in some variable (like resource scarcity, call it z) such that there is no effect up to some threshold level z^*, but that after z^* the slope is increasing in z. The model would be:

$$y=\begin{cases} 0*l + \epsilon \text{ if } z<z^* \\ \beta*(l*z) + \epsilon \text{ if } z>z^* \end{cases}$$

Now, as a example, assume l and z are normally distributed and uncorrelated and that the threshold point z^* is such that f percent of the observations lie above the z^*. If a linear regression on the whole sample is estimated, the coefficient will be $\delta = f*\beta*(\bar{z}^*)$, where $\bar{z}^* = mean(z) \text{ if } z>z^*$. If f=.10 and $\beta = 2$, for example, $\delta = .10*2*1.69 = .338$. If on the other hand the sample is divided in half and the regression is run only on those observations

other hand the sample is divided in half and the regression is run only on those observations where z is above its mean then this automatically doubles the fraction of the sample in which the slope is positive and hence raises the estimated coefficient to $\beta = .1*2*1.69/(.5) = .676$.

Since the estimated impact on the sample in the bottom half of z values is zero, the difference between the estimates depends on the fraction above the threshold and the average slope above the threshold. So, if the division of the sample along characteristic z fails to produce substantatively different results then either a very small fraction of the sample lies above the threshold region (which does not deny a threshold above which population growth is detrimental) or the difference in impact above and below the threshold is not very large (perhaps because characteristic z (as measured) is not really an important interactive term). This result is true whatever the true functional form of the increased impact of population growth.

III) Data and Methods

Output per worker is taken from the Penn World Tables 5 (Summers and Heston, 1991). Output is real GDP measured at 1985 "real" dollars, that is adjusted for variations across countries in purchasing power. Output levels using these PPP currency conversions should be comparable over time and across countries[11].

Using labor force growth instead of either population growth (as most studies do) or growth of the working age population (Mankiw, Romer, Weil 1992) is empirically and conceptually important. It is empirically important as it allows the decomposition of changes in output per worker into factor accumulation and per worker productivity, which is performed

[11] Since the focus is on growth rates, nothing of substance would change if World Bank constant price local currency GDP data were used as the cross country correlations in growth rates are very high between the two series.

in a companion paper (Pritchett, 1994). Since the correlation between the growth rate of population and the growth rate of labor force is not exceptionally high, the distinction may matter in the estimation[12].

Conceptually the distinction is also important, as most theories as to why population growth should negatively affect welfare growth are about its detrimental impact on the growth of labor productivity, not its effect on labor force participation[13]. There are two other reasons for preferring to focus on output per worker for welfare comparisons. First, output per person could change due to rapid population growth simply because of changes in the age structure of the population, as dependency rates (ratio of those not in the labor force to those in the labor force) vary substantially across countries with different demographic patterns. This implies that even if lifetime income were the same for each generation regardless of cohort size (output per worker and participation rates were constant), GDP per person would first rise and then fall with a decrease in the birth rate-but with decidedly ambiguous welfare consequences[14].

Second, for many reasons GDP per capita is an awful measure of welfare (because it doesn't take account of externalities, it doesn't account for the depletion of the stock of natural capital, etc.) but in its usual uses GDP per capita is at least equally awful across comparisons of two situations and hence the level of its awfulness does not affect the welfare comparisons

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[12] Regressing labor force growth 1960-90 on population growth 1960-90 gives an R^2 of .65. For decades, regressing labor force growth on population growth lagged a decade produces R^2 of .72 for the 1980s and .52 for the 1970s.

[13] There is some evidence that most of even the modest negative effect on output per person of population growth that most studies find is primarily through its effect on labor force participation (Brander and Dowrick, 1994, Pritchett, 1994).

[14] The addition of a wanted child in a household increases welfare but lowers output per capita in the household substantially.

of changes. This is not the case for demographic changes, as the labor force participation of women typically (although of course not necessarily) account for a large fraction of home production. Since home production is not valued in GDP, marginal welfare gains from increased labor force participation of women are recorded as first order changes in GDP per capita.

In estimating the relationship between the growth rate of output per worker[15] and the growth rate of population there are two approaches to adding control variables. The first adds policy or structural correlates of growth to a reduced form equation. The second begins with a production function and controls for factor accumulation. This paper only reports the first approach. In order to provide consistency across correlations reported we report the partial correlation coefficient of I with y in three forms[16]; a) bivariate, with no control variables, b) using just initial per capita income as a control variable, and c) including other policy indicators along with initial income. The policy indicators included are the black market premium (BMP), financial depth (LLY, the ratio of liquid liabilities to GDP), and openness (XS, the ratio of exports to GDP). Since these other growth correlates are of only secondary interest in this exercise, all that will be reported is the partial correlation with population after including the controls.

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[15] All growth rates are calculated as least square growth rates over the specified period.

[16] That is even when we are performing a bivariate regression we do not present the bivariate correlation, ρ, but the coefficient from the linear regression, β. In bivariate regression the relationship is simply $\rho = \beta*(\sigma_x/\sigma_y)$. Reporting the slope coefficient rather than the correlation for the bivariate regressions preserves the scaling for easier comparison with the multivariate results.

A second way of examining economic growth, not pursued in this paper, is to specify a production function which would allow a decomposition of the growth rate of output per worker into factor deepening (the growth of physical capital and education stock per worker) and TFP growth:

$$y = \alpha_K * k + \alpha_H * h + TFP$$

where k and h are the growth rates of physical capital per worker and human capital per worker respectively. Then in order to estimate the total impact of labor force growth on output growth one needs to decompose the effect between the effect of more rapid l on k,h, and TFP. In a companion paper (Pritchett, 1994) we use recently created data on the physical capital stock (Nehru and Dhareshewar, 1993) and years of schooling (Nehru, Dubey, Swanson, 1994, Barro and Lee 1993) to calculate this decomposition. The result of which is that more rapid population growth is not associated with slower growth of capital per worker, is not associated with slower growth of the schooling of the labor force, and is mildly associated with slower TFP growth[17]. This paper will focus on the non-production function estimates.

Availability of data us to work with a sample of 78 countries of which 22 are OECD and 56 are developing (in this case developing is defined as non-OECD) countries[18].

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[17] The real difficulty with implementing this approach turns out to be the estimation of the impact of factor accumulation on growth as the augmented Solow model (a la Mankiw, Romer, Weil, 1992) imposes theoretical restrictions on the coefficients (e.g., that they be equal to factor shares in GDP) that the data have difficulty supporting. Pritchett (1994) is agnostic about TFP measurement, using coefficients both from estimation and from theory.

[18] Except for Turkey, which is included as a developing country.

Two final methodological notes are about the use of OLS for estimation and the time horizon for growth rate calculation. Since labor force growth is in part determined by income growth, estimates of the income growth-labor force growth relationship are potentially affected by their joint endogeneity. The estimates presented do not correct for this problem for three reasons. First, since labor force growth is by and large predetermined by earlier population growth (although there are some participation effects) the endogeneity should be less severe in this case than in those studies that use contemporaneous population growth. Second, if more rapid income growth reduces population growth then whatever simultaneity bias there is should bias towards finding a more negative relationship. Since the primary puzzle is that the relationship is not as negative as people expect, correcting this bias would only reduce the already small population effect. Third, our experimentation with instrumental variables estimates (using either lagged labor force growth, lagged births or lagged child mortality) gave similar results-but with significant added imprecision due to instrumentation.

Except for a small section below, all the results reported are over the 30 year period from 1960-1990[19]. There is a good reason. If one is interested in long-run relationships the use of high frequency data is unlikely to add much information. Earlier research (Easterly, et al, 1993) has shown that there is very little persistence of economic growth rates across periods as long as a decade. In contrast, population growth rates change only quite slowly[20]. Therefore, while moving to annual data or 5 year periods would add a large number of

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[19] Or as much of that period was available. If data was only available 1962-1990 for instance, we just used the growth rate over that shorter period.

[20] Even in the ideal situation in which population was actually observed at high frequency. In most developing country cases much of the data about population is interpolated into to create complete series and so cannot represent real information useful for estimation in any case.

observations this data would also add a great deal of noise relative to real information about the relationship of interest between long-run population and economic performance and hence is unlikely to improve the estimates. That said, we produce and report results using ten year data in a section below and in appendix tables.

IV) Basic Results: Labor force growth and output per worker

Table 3 presents the correlations of population and growth over the entire period. The three columns report three partial correlation coefficients; the bivariate partial correlation and the multivariate partial correlation, controlling for just initial income in one instance and for other established policy growth correlates in addition to lagged income in another. The bivariate results are similar to the bulk of the previous literature of cross country regressions: a small and statistically insignificant correlation. Over the whole sample the correlation is slightly negative (-.10), but insignificant, the p-value is .37[21]. Both sets of partial correlations are nearly the same as the bivariate correlations. Adding our set of control variables (chosen from a review of the literature searching for robust growth correlates) does not change substantially the estimated impact of labor force growth, if anything, it reduces the estimated impact[22].

A) Results by region

The first question is whether or not the effect of population growth varies across groups of countries, defined either by region or income class. Surprisingly, when the effect is allowed

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[21] Throughout the paper the tables present p-values, which is the significance level of the test that the coefficient is different from zero. A p-value of .10 (.05 (.01)) for the partial correlation for instance is referred to as rejecting the null hypothesis of zero at the 10 (5 (1)) percent significance level.

[22] This is not surprising if the policy regimes are uncorrelated (or only weakly correlated) with labor force growth as the excluded variable bias on the labor force growth coefficient would be zero.

to vary across developed and developing countries we find all of the negative effect on economic performance is in the OECD countries, where the effect of labor force growth is strongly negative and significant[23]. On the other hand the estimated effect in the developing countries is positive, .15, (although insignificant). This seems to imply that the slope of the economic growth-population growth relationship depends is not constant but that, contrary to intuition, labor force growth is worse for the richer industrialized than developing countries.

Table 3: Partial Correlation of Labor Force Growth with Growth Rate of Output per Worker, 1960-1990. Sample divided by regions.

Control variables:	None	Y_0	Y_0,BMP,LLY,XS	
All	-.10 (.37)	-.12 (.28)	0.04 (.73)	79
OECD	-.50 (.02)	-.08 (.07)	-.04 (.89)	22
Developing	0.15 (.25)	0.16 (.24)	0.10 (.48)	56
Africa	-.01 (.98)	0.02 (.93)	-.09 (.73)	19
Latin America	0.32 (.20)	0.33 (.19)	0.50 (.07)	18
Asia/ Pacific	0.60 (.04)	0.66 (.03)	0.75 (.03)	12

Notes: p-levels of the test for zero correlation are in parenthesis.

[23] This result is the same as Mankiw, Romer, Weil find with the estimated impact higher and statistically significant in the OECD (-.21) while smaller (-.14) in LDCs.

The fourth through sixth rows of table 3 show the impact across geographical regions of the developing world. The effect is clearly worst in Africa-although only because it is slightly (and insignificantly) negative -.01, while the other estimates are positive. In Latin America and Asia/Pacific the labor force growth partial correlation effect is actually positive (.50 and .75) and statistically significant (at the 3 percent level for Asia and 7 percent for Latin America). This is consistent with other studies which tend to find the largest negative (although not always statistically significant) effects in Africa (see appendix table A1.1). However pure regional effects are always somewhat suspicious as it would be preferable to identify the empirical feature African countries share that produces this effect rather than packing it into the unexamined label of "Africa."

The next logical way to divide the sample is by level of output per worker. Here, the same puzzling result is found. The impact of labor force growth is as bad (or worse in the bivariate correlations) in the middle income countries as in the low income countries. Table 4 shows that for both income groups the impact is very small (-.05 Middle, -.02 Low) and emphatically insignificant (p-levels of .82 and .94). This finding by income group is consistent with Brander and Dowrick, 1994, who also find the estimated impact of population growth as bad or worse in the richer than the poorer countries[24]. Kelley and Schmidt (1994) also frequently show a small and insignificant interaction term which suggests that countries with higher levels of per capita income have a more negative impact of population growth that poorer

[24] Brander and Dowrick use a search over Chow test values for sample separation to divide their sample by per capita income at the statistically "optimal" point.

countries[25]. Statements that population growth is worse in poorer countries have yet to attract much, if any, empirical support.

Table 4: Partial Correlation of Labor Force Growth with Growth Rate of Output per Worker, 1960-1990. Sample divided by income class.

Control variables:	None	Y_0	Y_0,BMP,LLY,XS	
All	-.10 (.37)	-.12 (.28)	0.04 (.73)	79
OECD	-.50 (.02)	-.08 (.07)	-.04 (.89)	22
Low Income	0.05 (.83)	0.07 (.75)	-.05 (.82)	24
Middle Income	-.12 (.51)	-.12 (.53)	-.02 (.94)	32

Notes: p-levels of test for zero correlation in parenthesis.

B) Results by land endowment per rural individual

The previous results, dividing the sample by region, level of development, or income, have not yet solved our puzzle of discovering for which group of countries population growth has a negative effect. One possible rationale is that the level of resources available for expansion of production is more important than the level of income. While population expansion may have a negative effect in poor and land poor Bangladesh it may not have the same impact in poor, but land rich, Zambia. This resource depletion effect of population growth should be higher the larger the dependence on natural resources in fixed supply and the nearer the

[25] Kelley and Schmidt (1994) table 3 shows negative linear interaction terms in the 1960's and 1970's but a small positive interaction term in the 1980s. The results with interaction terms using an LDC only sample are more ambivalent with a positive interaction term in the 1960s and 1980s and a negative term in the 1970s (appendix table C2). All of the estimated interaction terms (positive and negative) are statistically insignificant.

exhaustion of possibilities for expansion at the extensive margin (that is, the lower the marginal productivity of additional natural resources brought into production)[26].

However, quantifying which countries are "resource poor" is elusive. Simple population density won't do. Would more population growth be a good thing in Hong Kong or Singapore? By any simple land density measure these are exceptionally "resource poor" economies yet both have had relatively rapid population growth while maintaining extraordinary economic performance.

Pure agricultural potential won't do, as the composition of output affects the magnitude of the effect on population as is clear in the case of the more advanced economies[27]. Since the utilization of resources accounts for a very small portion of measured GDP in industrialized countries the availability of land is unlikely to be a major constraint to growth even in densely populated Belgium. Also, agricultural potential is a limited measure because land is not the only resource. Would more population growth be good or bad for economic growth in Saudi Arabia (or any other small oil state) following a huge increase in wealth? If capital accumulation is unconstrained the factor shallowing effects of rapid population growth may not emerge.

Because (and in spite of) these considerations the measure we settle on in this paper is "arable land per rural worker." This has the benefit over population density of (roughly)

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[26] For instance, Kelley (1988) suggests "Population's adverse impact has most likely occurred where arable land and water are particularly scarce or costly to acquire."

[27] We did originally consider using the measure of "carrying capacity" derived by FAO (FAO, 1984) which calculates the potential food production per person based on data about soils and climates and agricultural productivity. However, this suffers the same difficulty of land density measures-that densely populated highly urbanized areas are classified as having population in excess of the land's carrying capacity. For instance, the ratio of population supporting capacity to actual population in 1975 in the intermediate input usage case was 1.31 for Bangladesh, 1.67 for Egypt (compared to 44.88 for Zambia, 16.75 for Argentina) but was near zero for Singapore. To use this as an indicator of population pressures would suggest much worse problems in Singapore than Bangladesh.

excluding sparsely populated because mostly uninhabitable lands (e.g. Libya) and also correcting for the Hong Kong type situation with high density but no rural population and little or no agricultural output from land in any case. This measure does seem to capture part of the distinction as seen from table 5, which shows representative land rich and land poor countries. There is huge variation across countries, as the most land poor countries have only about a tenth the land as the land rich. The rankings of land poor correspond to intuition as countries like Egypt, Indonesia, and Bangladesh show up as extremely dense. On the other hand there is more uncertainty about the land rich rankings, as the measure of "arability" must play a role for suggesting Botswana is land rich. The measure does seem to do a good job of dividing up Africa into land rich (e.g. Zambia) and land poor (e.g. Liberia or Ghana (678)). On the down side, we had to delete Singapore from the land poor sample in an entirely ad hoc way, as the data recorded a rural population and hence it was classified as land poor.

Table 5: Representative land poor and land rich countries as classified by arable land per rural person (in 1980).

Land Poor (more than twice the average density)		Land rich (less than half the average density)	
Country	Rural population per square arable kilometer	Country	Rural population per square arable kilometer
Sri Lanka	1324	Botswana	56
Egypt	1004	Zambia	66
Liberia	969	Brazil	67
Malaysia	904	Senegal	69
Bangladesh	846	Venezuela	81
Indonesia	810	Syria	87
Korea	796	Tunisia	95
Kenya	777	Bolivia	95
Haiti	752	Turkey	98

Notes: Average density is 376 rural people per square arable kilometer.

How do the regressions with the sample divided by "land poor" and "land rich" behave? Not very well. In table 6 the estimated effect is more severe in the land rich than the land poor countries. In the multivariate regressions the effect was even positive for the land poor (.21) while negative (-.10) in the land rich (although again, both are insignificant). Since creating this empirical division into land rich and land poor was a major part of the research and frankly, our best idea, this lack in intuitive results is very disappointing.

Table 6: Partial Correlation of Labor Force Growth with Growth Rate of Output per Worker, 1960-1990. Sample Divided by Land Scarcity.				
Control variables:	None	Y_0	Y_0,BMP,LLY,XS	N
All	-.10 (.37)	-.12 (.28)	0.04 (.73)	79
Land Poor (w/o Singapore)	-.05 (.77)	-.03 (.85)	0.21 (.24)	38
Land Rich	-.21 (.20)	-.29 (.07)	-.10 (.57)	40
Notes: p-levels of test for zero correlation in parenthesis.				

C) Changes in the results over time

A final way in which the impact of population may vary is over time. The difference in the correlation in the 1980s has been widely noted. However, it is very difficult to interpret what this time-varying coefficient may mean if the shift cannot be empirically related to some underlying time varying variable. That is, it may be that the impact of population growth is worse at higher densities, and that population density has been increasing over time. But if that were the case is should be possible to control in the regressions for shifting density and eliminate the exogenous time shift.

In any case in our present results using labor force growth the effect is in fact larger in the 1980s, although not statistically significant. This is consistent with other findings, such as Kelley and Schmidt, 1994 and Brander and Dowrick, 1994. However, what this result for the 1980s implies about the evolution of the future impact of population growth is unclear. Will the impact of population growth in the 1990s be like that of the 1970s or 1960s or like that of the

1980s? Unless one can identify the empirical reason for the shifting coefficient in the 1980s the finding is interesting, but uninformative. That is, if the worse impact of population growth in the 1980s were due to greater density as population grew this density effect should appear in the cross sectional results. As it is, one has no idea why the impact may be different in the 1980s.

Table 7: Partial Correlation of Labor Force Growth with Growth Rate of Output per Worker. Developing country sample. Regression by decade.

Control variables:	None	Y_0	Y_0,BMP,LLY,XS	N
All	0.15 (.25)	0.16 (.24)	0.10 (.48)	56
1960-70	0.12 (.38)	0.11 (.43)	0.12 (.41)	56
1970-80	0.06 (.67)	0.02 (.90)	0.001 (.99)	56
1980-90	-.11 (.40)	-.10 (.48)	-.18 (.19)	56

Notes: p-levels of test for zero correlation in parenthesis.

Conclusion

The data say very strongly that labor force growth has a very small, empirically insignificant association with the growth of output per worker. However, very few who work on population issues believes this average impact is true for all countries. This is a justifiable reaction, in part because no one trusts the constraints forced on the data. The usual econometric formulation presupposes that the negative (or positive) effect of population growth should be the same everywhere. But we don't believe the negative affect of additional population will be the same in Bangladesh and in Canada, nor even the same in crowded Malawi or Rwanda as in sparsely populated Zambia or Zaire.

This paper has attempted to implement that intuition empirically to advance the debate about the consequences of population growth. Unfortunately, it did not make much progress. The results did not give striking confirmation to any of the plausible distinctions across countries. Our measure of resource scarcity is likely a major reason for this failure. However, while our empirical measure has its defects and fails to produce satisfying results, it is a major conceptual improvement over even more simple indicators, like population density, and of course even a greater improvement over the literature's standard: nothing at all.

Identification of the conditions under which population growth is a drag on economic growth (along with of course those countries for which population growth presents other dangers, such as degradation of critical environments) ought to be a priority. Efforts to reduce population growth should be concentrated in those countries in which the return to those efforts are anticipated to be the highest and one element of a high return is where the economic problems imposed by additional population growth are the most severe. But this focus of effort requires some ability to objectively identify and quantify those countries for which population growth will have the worst effects. Although there have been many plausible conjectures made about where population growth will be bad (e.g. worse in poor countries, worse in land scarce countries, worse with poorer policies) there currently is no empirical evidence at all to support those conjectures. This is a major lacunae in our knowledge about population and its impacts.

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Appendix Table A1.1: Estimates of Impact of Population Growth on Per Capita Economic Growth

Study	Dependent Variable (source)	Coefficient	t stat	Other Variables Controlled	Period	Sample	Ind. Variable
Levine & Renelt (1992)	YPC (WB)	-.15	.79	y0, I/GDP, SEC, PRI, GOV, SOC, REVC, AF, LAM, GDC, STDDC, X/GDP, CVL	1960-85	101 DC's and LDC's	Population Growth
Brander & Dowrick (1994)	YPC (PWT5)	-.02 (OLS) -.27 GLS (IV)	.1 .7	I/GDP, LRP, LRP^2, LF/POP	Random effects with 5 year averages (1960-85)	107 DC's and LDC's	Population Growth
Kelley and Schimdt (1994)	YPC (PWT5.5)	.34 (-.12) .09 (-.09) -1.57 (.06)	.63 (1.1) .16 (1.1) 3.2 (.73)	$Y0, Y0^2, Y0^3$, Density, ln(Popl), (Interaction of pop'l growth with y0 (interaction results given in parenthesis)	1960-70 1970-80 1980-90	89 DCs and LDCs.	Population growth
Barro (1991)	YPC (PWT5)	-.14	2.15	y0, SEC_0, PRI_0, GOVC/GDP, REVC, ASSN, IPPDEV, AF, LAM	1960-85	98 DC's & LDC's	Net Fertility
Mankiw, Romer & Weil (1992)	GDP per person aged 15-64 (PWT5)	-.14	1.75	y0, I/GDP, SCHOOL	1960-85	non-oil	Growth of population aged 15-65
		-.15	1.91	y0, I/GDP, SCHOOL		non-oil intermediate	
		-.21	2.52	y0, I/GDP, SCHOOL		OECD	
Landau (1986)	YPC	-.199	.93	I_{pvt}, GOV (-m-E), Y_0, EdExp/GDP, MS, I_{gov}, Trend, transfers, school enrollment, distance to nearest seaport	1960-80 7 year averages	65 LDCs > 1 mil. pop.	Population Growth
Ram (1986)	YPC	-.403	1.51	I/GDP, GOV	1960-70	94 LDCs	Population Growth
		-.306	.87		1970-80		
Diamond (1989)	YPC	-.78	1.32	I_{pvt}, I_{pub}	1980-85	38 LDCs	Labor Force Growth
Cordoso & Fishlow (1989) (table 2, col 5, p. 13)	YPC	-.20	.93	I/GDP, X, m, D_{50-65}	1950-80, five year averages	18 Latin American	Labor Force Growth

Skinner (1987)	YPC	-.658	1.27	OIL, COUPS, I_{pvt}, I_{pub}, ToT, taxes of various types	1965-82	31 African	Population Growth
Otani & Villa Nueva (1990)	Growth of per capita real GNP (IMF)	-1.13	1.62	S/GDP, EdExp/GOV, RIR, X/GDP	1970-85	17 low income LDC's	Population Growth
		-1.32	1.78			15 middle income LDC's	
		-.66	.74			23 upper income LDC's	
Grier & Tallock (1989)	YPC (SH, PWT4)	-.606	1.47	y0, GOV, S/GDP, INF, STDINF, OPEC, LIB	1961-1980 using five year averages	43 SS African	Mean Population Growth
		-.339	1.04			24 Latin Am.	
		-.746	.91			22 Asia & Far East	
Kormendi & Meguire (1985)	YPC IMF	-.42	2.47	y0, Sy, STDMS, MS, X/GDP, GOV, INF	1950-77	47 countriesDC & LDC	Population Growth
		-.37	2.17				

Notes: 1) Dependent variables, YPC: growth rate of GDP per capita. Sources: PWTXX indicates various versions of the Penn World Tables, WB is World Bank national accounts, while IMF indicates IMF national accounts data.

2) Control variables: Y0, initial income; I/GDP, ratio of investment to GDP; PRI (SEC), primary (or secondary) enrollment rate; GOV, ratio government spending to GDP; SOC, dummy for socialist economies; REVC, revolutions & coups; AF, dummy for sub saharan Africa; LAM, dummy for Latin America; X/GDP, ratio exports to GDP; GDC, growth of domestic credit; STDDC, standard deviation of domestic credit; CVL, civil unrest; SCHOOL, weighted average primary and secondary enrollment; LRP, log deviation of output per worker from US levels; LF/POP, ratio of labor force aged population to total population; DENSITY, ratio of land area to population, S/GDP, domestic savings ratio; GOVC/GDP, ratio of government consumption spending to GDP, ASSN, Assassinations, IPPDEV, deviation of investment prices from expected level based on income per capita; EdExp/GOV, fraction of govt. expenditure on education; MS, growth of money supply; STDMS, standard deviation of money supply; X/GDP, ratio of exports to GDP; RIR, real interest rate; Ipvt, private investment; Ipub, public investment; ToT, terms of trade shocks; LEX, life expectancy at birth; INF, inflation; STDINF, standard deviation of inflation; OPEC, dummy for OPEC; LIB, dummy for lack of civil liberties.

3) Net fertility is fertility adjusted for infant mortality.

4) All coefficients reported in original sources are transformed so that it indicates the effect of an increase of one percentage point in population growth on the growth of output per person per annum (i.e., if the coefficient is .38, a 1% increase in population growth reduces output per person by .38% of percentage points).

Appendix Table A2-1: Partial Correlation of Labor Force Growth on Growth Rate of Output per Worker, for Various Samples of Countries, 1960-1990

Control variables:	None	Y_0	Y_0,BMP,LLY,XS	N
All	-.10 (.37)	-.12 (.28)	0.04 (.73)	79
OECD	-.50 (.02)	-.08 (.07)	-.04 (.89)	22
Developing	0.15 (.25)	0.16 (.24)	0.10 (.48)	56
Africa	-.01 (.98)	0.02 (.93)	-.09 (.73)	19
Latin America	0.32 (.20)	0.33 (.19)	0.50 (.07)	18
Asia/Pacific	0.60 (.04)	0.66 (.03)	0.75 (.03)	12
Low Income	0.05 (.83)	0.07 (.75)	-.05 (.82)	24
Middle Income	-.12 (.51)	-.12 (.53)	-.02 (.94)	32
Land Poor w/o SGP	-.05 (.77)	-.03 (.85)	0.21 (.24)	38
Land Rich	-.21 (.20)	-.29 (.07)	-.10 (.57)	40

Notes: 1) Number in parenthesis is the p-level of the test the correlation is zero.
2) Control variables: Y0 is initial income, BMP is the black market premium, LLY is the ratio of liquid liabilities to GDP, XS is the export to GDP ratio.

Appendix Table A2-2: Partial Correlation of Labor Force Growth with Growth Rate of Output per Worker for various Samples of Countries, 1960-1969.

Control variables:	None	Y_0	Y_0,BMP,LLY,XS	N
All	-.26 (.02)	-.25 (.03)	-.07 (.55)	79
OECD	-.51 (.02)	0.04 (.84)	-.33 (.19)	22
Developing	0.12 (.38)	0.11 (.43)	0.12 (.41)	56
Africa	-.06 (.80)	-.03 (.92)	-.20 (.49)	19
Latin America	0.31 (.21)	0.31 (.23)	0.45 (.10)	18
Asia/Pacific	0.62 (.03)	0.70 (.02)	0.82 (.01)	12
Low Income	0.05 (.83)	0.02 (.92)	-.19 (.43)	24
Middle Income	-.28 (.13)	-.31 (.09)	-.17 (.39)	32
Land Poor w/o SGP	-.20 (.21)	-.19 (.26)	-.08 (.67)	38
Land Rich	-.30 (.05)	-.32 (.05)	0.09 (.62)	40

Notes: 1) Number in parenthesis is the p-level of the test the correlation is zero.
2) Control variables: Y0 is initial income, BMP is the black market premium, LLY is the ratio of liquid liabilities to GDP, XS is the export to GDP ratio.

Appendix Table A2-3: Partial Correlation of Labor Force Growth with the Growth Rate of Output per Worker for Various Samples of Countries, 1970-1979

Control variables:	None	Y_0	Y_0,BMP,LLY,XS	N
All	0.05 (.67)	0.04 (.76)	0.08 (.48)	79
OECD	-.22 (.33)	-.08 (.72)	0.12 (.64)	22
Developing	0.06 (.67)	0.02 (.90)	0.01 (.99)	56
Africa	.03 (.89)	0.01 (.96)	0.03 (.90)	19
Latin America	0.13 (.60)	0.22 (.40)	0.08 (.81)	18
Asia/Pacific	0.17 (.59)	0.08 (.81)	0.47 (.24)	12
Low Income	-.03 (.90)	-.03 (.90)	0.04 (.87)	24
Middle Income	-.06 (.74)	-.02 (.93)	-.10 (.62)	32
Land Poor w/o SGP	0.07 (.67)	0.09 (.59)	0.02 (.92)	38
Land Rich	0.04 (.83)	-.01 (.97)	0.20 (.24)	40

Notes: 1) Number in parenthesis is the p-level of the test the correlation is zero.
2) Control variables: Y0 is initial income, BMP is the black market premium, LLY is the ratio of liquid liabilities to GDP, XS is the export to GDP ratio.

Appendix Table A2-4: Partial Correlation of Labor Force Growth with Growth Rate of Output per Worker for Various Samples of Countries, 1980-1990

Control variables:	None	Y_0	Y_0, BMP, LLY, XS	N
All	-.23 (.04)	-.23 (.04)	-.27 (.02)	79
OECD	-.43 (.05)	-.46 (.04)	-.59 (.01)	22
Developing	-.11 (.40)	-.10 (.48)	-.18 (.19)	56
Africa	0.05 (.85)	0.08 (.74)	0.11 (.69)	19
Latin America	-.18 (.48)	-.19 (.47)	-.26 (.37)	18
Asia/Pacific	-.33 (.30)	-.33 (.32)	-.23 (.57)	12
Low Income	-.04 (.85)	0.01 (.98)	0.12 (.61)	24
Middle Income	-.15 (.42)	-.15 (.43)	-.33 (.08)	32
Land Poor w/o SGP	-.15 (.38)	-.21 (.20)	-.17 (.33)	39
Land Rich	-.42 (.01)	-.25 (.14)	-.36 (.04)	39

Notes: 1) Number in parenthesis is the p-level of the test the correlation is zero.
2) Control variables: Y0 is initial income, BMP is the black market premium, LLY is the ratio of liquid liabilities to GDP, XS is the export to GDP ratio.

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